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Temperature-Monitoring and Safety-Control Device

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Armond E. Lemke and Walter F. Dawson	
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16. ABSTRACT

A two channel (sensitive) temperature monitor is described, and a parts list and wiring diagram are given. This equipment can be used as a safety shut-off or alarm system, or both. The sensitivity is 0.3°C.

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Temperature-Monitoring and Safety-Control Device

Experimental work involving poikilothermic animals such as fish and aquatic invertebrates requires close control of temperature. A temperature controller developed previously at our laboratory (Syrett and Dawson 1972) met that need. The usefulness of the controller was often negated, however, by failure of other system components, such as valves or heaters, or by loss of water flow. This report describes a solid-state monitoring apparatus that has a variable set point and variable diversion from set point as well as an output to a single alarm system for alerting personnel when diversion occurs. The set point can be varied continuously from 0 to 50°C, and the diversion can be varied from 0.3 to 2.0°C.

In operational configuration the apparatus constitutes a Wheatstone bridge that incorporates a thermistor in one arm and an adjustable resistance in another arm (Fig. 1). The thermistor is exposed in the medium to be monitored for temperature. Through suitable adjustments of the adjustable resistance means, the bridge can be balanced at a given temperature from 0 to 50°C. When the monitored temperature increases or decreases from the designated balancing temperature, an output voltage signal is provided, the polarity of which is indicative of the direction of temperature deviation. The output voltage signal is amplified and passed on to the relay circuit, which enables use of a higher power output. A manually operable switch (such as a double-pole double-throw switch) is provided for selectively inverting the polarity of the output voltage signal, which enables control of a heating or cooling circuit as desired.

In normal configuration water enters the test system through a normally closed solenoid that is maintained in the open position by the amplifiers' relay circuit. Deviation from the given temperature causes the two amplifiers that operate independently of each other to become unpowered, which in turn allows the solenoid to close as a safety device (Fig. 2). The usual mode of operation is to have one of the amplifiers on each side of the desired set point. However, both may be set below or above the designated point without damage to the equipment, making it possible for one unit to monitor two separate systems. An integral part of the apparatus is a built-in safety shut-off of the incoming water that prevents disastrous temperature variation in the test system (Fig. 2).

A change of 0.3°C from set point causes a voltage signal to activate the integral relay, which causes a bell or other signal to be sounded. If power greater than 150 W is to be controlled, a triac or mercury relay can be added to do the switching.

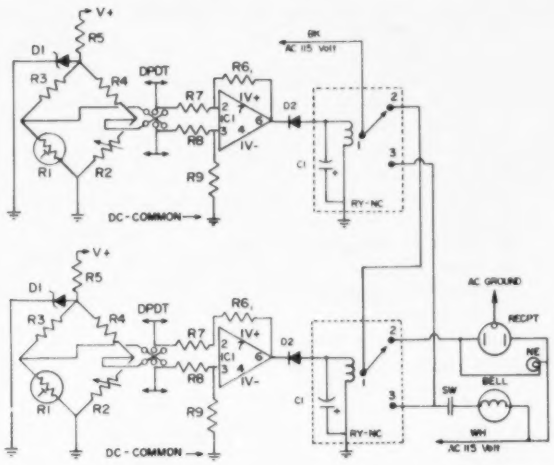

Fig. 1. Wiring diagram of double-circuit system.

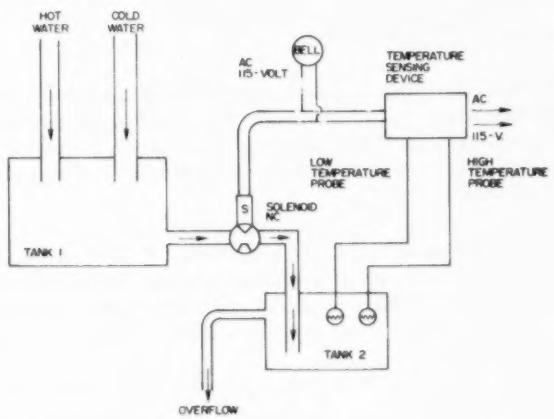

Fig. 2. Schematic diagram of overall safety cutoff and alarm system.

The parts list (Table 1) details all equipment necessary to complete the equipment except the wire to run to the solenoid and the power wire. The apparatus described has been extremely reliable; two units have performed for up to 3 years continuously, with no interrup-

Table 1. Parts list[a] for temperature-monitoring and safety-control device.[b]

Power supply dual 15 V DC 50mA	B.H. Electronics, 245 East 6th St., St. Paul, Minn. 55101
Chassis, 127. × 17.8 × 5.1 cm (5 × 7 × 2 in.) aluminum #AC-402 Bud	Allied Radio, 2400 Washington Blvd., Chicago, Ill. 650612
SW Switch DPDT #E2118	Calectro G.C. Electronics, Rockford, Ill. 61101
RY Relay 1760 ohms 12V #D1967	Calectro G. C. Electronics
NE Neon Lamp #B2150A1 (or any neon lamp	Industrial Devices Inc., Edgewater, N.J. 07020
DI Zener voltage regulator 3.9 V #Z1002-C	International Rectifier
D2 Diode #A-1000	Mallory
Ci 100 MFD 24V	
RI Temperature probe-type thermistor (#33A47) 2252 ohms at 25°C negative coefficient	Allied Radio or Victory Engineering Corp.
R2 Potentiometer 5K #CU-5021	Ohmite
R3 Resistor 2200 ohms ½ W 10%	
R4 Resistor 1200 ohms ½ W 10%	
R5 Resistor 10,000 ohms ½ W 10%	
R6 Resistor 1 megohm ½ W 10%	
R7 & R8 Resistor 100 ohms ½ W 10%	
R9 Resistor 1 megohm ½ W 10%	
SW SPST #273-048	Calectro G. C. Electronics
Bell or buzzer # 273-048	Radio Shack, Tandy Corp., Fort Worth, Tex. 76107
Recpt single recptacle #5251	Arrow-Heart Inc., Hartford, Conn.
Circuit Board #QTO18S	Continental Specialist Corp., 325 East Street, P.O. Box 1492 New Haven, Conn. 06509
IC1 #741-C U5B7741393	Fairchild
Jax #11	Switchcraft
Phone plug #260	Switchcraft
Extruded washers #6529-C	Calectro G. C. Electronics
Pointer knob #25-092 (for R2)	Calectro G. C. Electronics
Cover made of plexiglass 3.2 mm (⅛ in.) thick	

[a] Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Environmental Protection Agency.

[b] The parts cost of $50 makes this device available to low-budget operations.

tions. In addition, the use of thermistors in the area to be monitored rather than the frequently used mercury thermometers eliminates the possibility of thermometer breakage and subsequent contamination of the test chamber.

— Armond E. Lemke and Walter F. Dawson, *U. S. Environmental Protection Agency, Environmental Research Laboratory – Duluth, 6201 Congdon Boulevard, Duluth, Minn. 55804.*

Reference

Syrett, R.F., and W.F. Dawson. 1972. An inexpensive electronic relay for precise water temperature control. Prog. Fish-Cult. 34(4):241-242.

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